



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 21, 2024 – 03:28 AM EST

PDB ID : 4OU9
Title : Crystal structure of apocarotenoid oxygenase in the presence of Triton X-100
Authors : Sui, X.; Palczewski, K.; Kiser, P.D.
Deposited on : 2014-02-15
Resolution : 2.00 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Xtriage (Phenix) : 1.13
EDS : 2.36
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac : 5.8.0158
CCP4 : 7.0.044 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.36

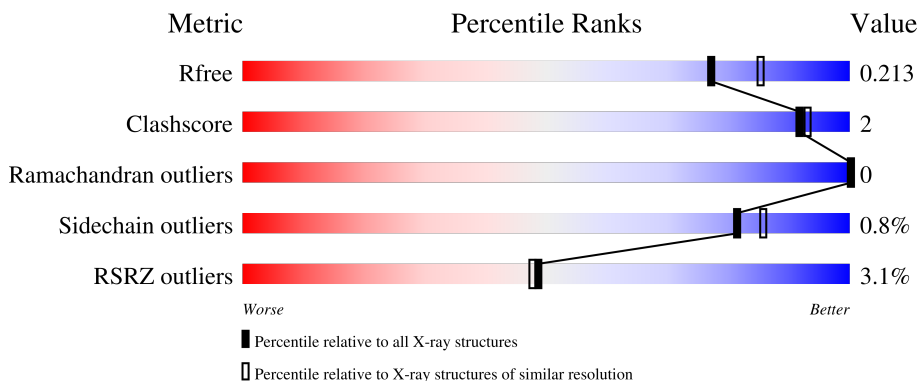
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.00 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	8085 (2.00-2.00)
Clashscore	141614	9178 (2.00-2.00)
Ramachandran outliers	138981	9054 (2.00-2.00)
Sidechain outliers	138945	9053 (2.00-2.00)
RSRZ outliers	127900	7900 (2.00-2.00)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	490	 3% 93% 5%
1	B	490	 2% 92% 6%
1	C	490	 3% 95%
1	D	490	 3% 92% 5%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 16035 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called Apocarotenoid-15,15'-oxygenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	481	3803	2439	656	698	10	0	3	0
1	B	481	3802	2438	657	697	10	0	3	0
1	C	479	3777	2423	652	692	10	0	1	0
1	D	479	3772	2421	650	691	10	0	1	0

- Molecule 2 is FE (II) ION (three-letter code: FE2) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Fe	0	0
			1	1		
2	B	1	Total	Fe	0	0
			1	1		
2	C	1	Total	Fe	0	0
			1	1		
2	D	1	Total	Fe	0	0
			1	1		

- Molecule 3 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Cl	0	0
			1	1		
3	B	1	Total	Cl	0	0
			1	1		

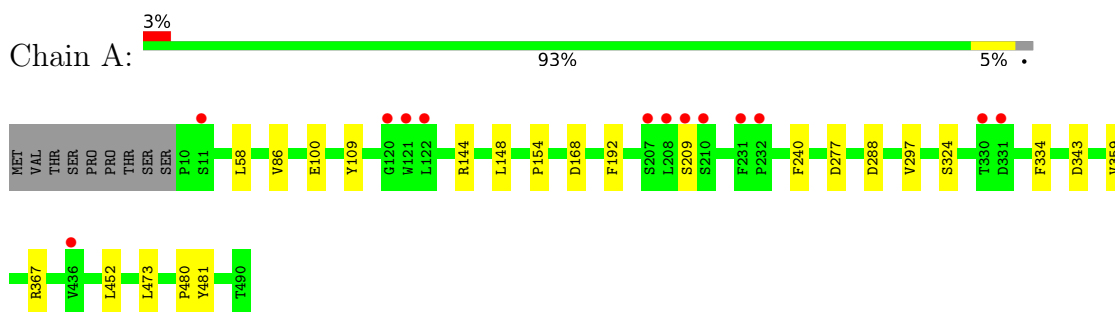
- Molecule 4 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	248	Total O 248 248	0	0
4	B	224	Total O 224 224	0	0
4	C	209	Total O 209 209	0	0
4	D	194	Total O 194 194	0	0

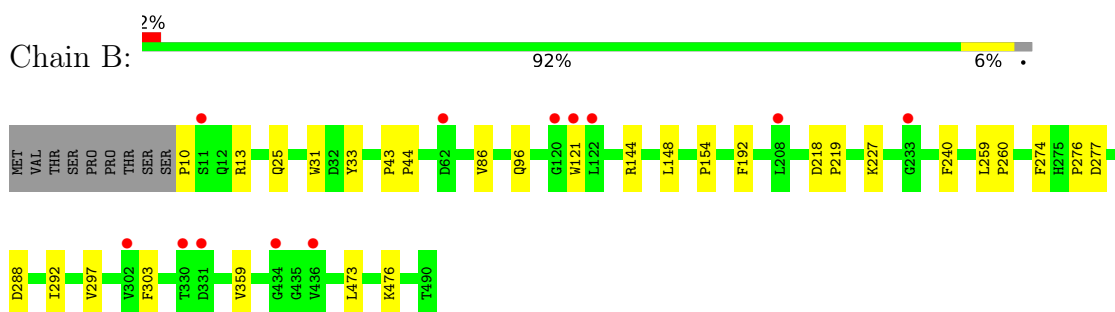
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ($RSRZ > 2$). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

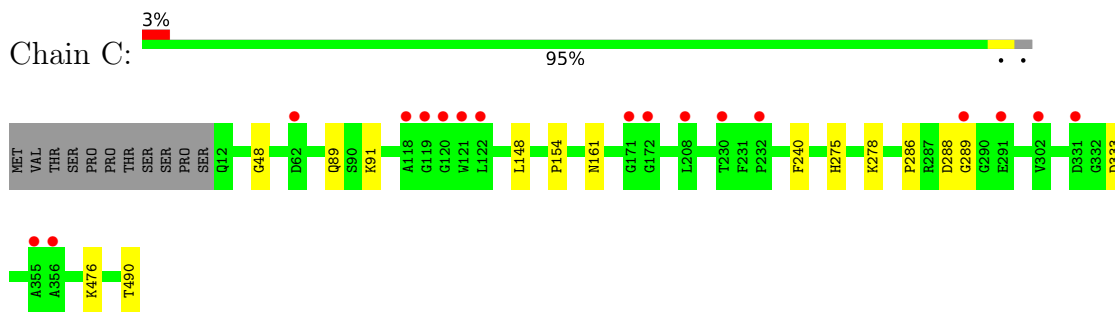
- Molecule 1: Apocarotenoid-15,15'-oxygenase



- Molecule 1: Apocarotenoid-15,15'-oxygenase

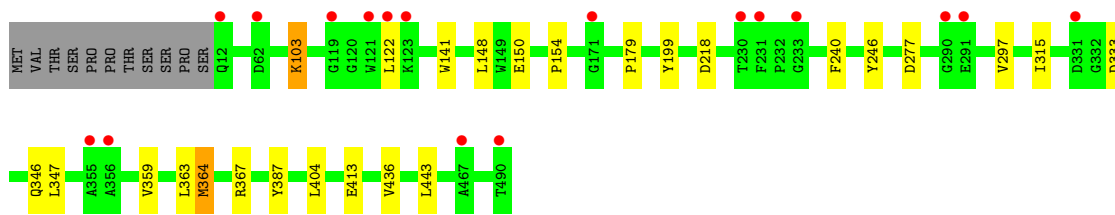


- Molecule 1: Apocarotenoid-15,15'-oxygenase



- Molecule 1: Apocarotenoid-15,15'-oxygenase





4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	118.47Å 125.39Å 202.54Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.61 – 2.00 48.61 – 2.00	Depositor EDS
% Data completeness (in resolution range)	98.7 (48.61-2.00) 98.7 (48.61-2.00)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.59 (at 2.00Å)	Xtrriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.177 , 0.205 0.186 , 0.213	Depositor DCC
R_{free} test set	9860 reflections (4.92%)	wwPDB-VP
Wilson B-factor (Å ²)	39.7	Xtrriage
Anisotropy	0.226	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 43.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	16035	wwPDB-VP
Average B, all atoms (Å ²)	46.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.81% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: FE2, CL

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	# Z >5	RMSZ	# Z >5
1	A	0.59	0/3920	0.73	2/5340 (0.0%)
1	B	0.63	0/3919	0.74	2/5337 (0.0%)
1	C	0.56	0/3890	0.70	1/5296 (0.0%)
1	D	0.56	0/3888	0.71	3/5295 (0.1%)
All	All	0.58	0/15617	0.72	8/21268 (0.0%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	B	0	1

There are no bond length outliers.

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	144	ARG	NE-CZ-NH2	5.70	123.15	120.30
1	D	364	MET	CG-SD-CE	-5.53	91.36	100.20
1	D	367	ARG	NE-CZ-NH2	5.52	123.06	120.30
1	C	333	ASP	CB-CG-OD1	5.44	123.19	118.30
1	A	367	ARG	NE-CZ-NH1	-5.32	117.64	120.30
1	D	277	ASP	CB-CG-OD1	5.29	123.06	118.30
1	B	144	ARG	NE-CZ-NH1	-5.20	117.70	120.30
1	A	367	ARG	NE-CZ-NH2	5.09	122.85	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	277	ASP	Peptide

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3803	0	3696	14	0
1	B	3802	0	3698	18	0
1	C	3777	0	3671	8	0
1	D	3772	0	3668	12	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	248	0	0	1	0
4	B	224	0	0	1	0
4	C	209	0	0	1	0
4	D	194	0	0	0	0
All	All	16035	0	14733	48	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 2.

All (48) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:86:VAL:HG11	1:A:473:LEU:HD13	1.60	0.83
1:B:86:VAL:HG11	1:B:473:LEU:HD13	1.60	0.82
1:A:58:LEU:HD11	1:A:334:PHE:CZ	2.32	0.64
1:A:277:ASP:HB3	1:B:31:TRP:HZ3	1.65	0.61
1:B:274:PHE:CZ	1:B:276:PRO:HA	2.38	0.58
1:A:277:ASP:HB3	1:B:31:TRP:CZ3	2.39	0.58
1:A:58:LEU:HD11	1:A:334:PHE:HZ	1.70	0.54
1:A:58:LEU:HB2	4:A:837:HOH:O	2.09	0.53
1:C:148:LEU:HD23	1:C:154:PRO:HB3	1.91	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:148:LEU:HD23	1:D:154:PRO:HB3	1.92	0.52
1:D:347:LEU:O	1:D:363:LEU:HD12	2.10	0.52
1:B:25:GLN:NE2	1:D:103:LYS:HB2	2.27	0.49
1:C:286:PRO:HB2	1:C:289:GLY:O	2.13	0.48
1:C:48:GLY:HA2	1:C:490:THR:HG23	1.94	0.48
1:D:297:VAL:HB	1:D:359:VAL:HG11	1.96	0.47
1:B:227:LYS:HE3	1:B:292:ILE:HD11	1.96	0.47
1:C:288:ASP:OD1	1:C:289:GLY:O	2.34	0.46
1:B:303:PHE:HB2	4:B:743:HOH:O	2.15	0.46
1:A:297:VAL:HB	1:A:359:VAL:HG11	1.97	0.46
1:A:192:PHE:CE1	1:A:288:ASP:HB3	2.51	0.46
1:C:91[B]:LYS:NZ	1:C:161:ASN:O	2.43	0.45
1:A:148:LEU:HD23	1:A:154:PRO:HB3	1.99	0.44
1:D:246:TYR:CE2	1:D:315:ILE:HD11	2.53	0.44
1:B:297:VAL:HB	1:B:359:VAL:HG11	2.00	0.43
1:B:218:ASP:HB2	1:B:219:PRO:CD	2.49	0.43
1:A:100:GLU:OE1	1:A:109:TYR:OH	2.27	0.43
1:B:473:LEU:N	1:B:473:LEU:HD23	2.33	0.42
1:B:96:GLN:NE2	1:B:96:GLN:HA	2.34	0.42
1:D:346:GLN:HB3	1:D:363:LEU:HD11	2.02	0.42
1:C:275:HIS:HB3	1:C:278:LYS:HG3	2.02	0.42
1:B:43:PRO:HA	1:B:44:PRO:HD3	1.93	0.42
1:D:404:LEU:HD11	1:D:413:GLU:HB3	2.01	0.42
1:A:144:ARG:NH2	1:A:168:ASP:OD1	2.52	0.42
1:B:25:GLN:HE22	1:D:103:LYS:HB2	1.84	0.42
1:A:324:SER:OG	1:A:343:ASP:OD2	2.26	0.41
1:D:150:GLU:O	1:D:179:PRO:HB3	2.20	0.41
1:D:218:ASP:C	1:D:218:ASP:OD1	2.59	0.41
1:B:259:LEU:HB2	1:B:260:PRO:HD3	2.02	0.41
1:C:476:LYS:NZ	4:C:725:HOH:O	2.52	0.41
1:D:387:TYR:CD2	1:D:443:LEU:HD11	2.55	0.41
1:B:10:PRO:HA	1:B:13:ARG:HG3	2.02	0.41
1:A:58:LEU:HG	1:A:58:LEU:O	2.21	0.41
1:C:89:GLN:OE1	1:C:161:ASN:HA	2.21	0.41
1:B:33:TYR:CD1	1:B:476:LYS:HE2	2.55	0.41
1:B:148:LEU:HD23	1:B:154:PRO:HB3	2.03	0.41
1:B:192:PHE:CE1	1:B:288:ASP:HB3	2.57	0.40
1:D:141:TRP:CE2	1:D:199:TYR:HB2	2.57	0.40
1:A:480:PRO:O	1:A:481:TYR:C	2.60	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	482/490 (98%)	473 (98%)	9 (2%)	0	100	100
1	B	482/490 (98%)	471 (98%)	11 (2%)	0	100	100
1	C	478/490 (98%)	469 (98%)	9 (2%)	0	100	100
1	D	478/490 (98%)	468 (98%)	10 (2%)	0	100	100
All	All	1920/1960 (98%)	1881 (98%)	39 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	404/410 (98%)	401 (99%)	3 (1%)	84	88
1	B	404/410 (98%)	402 (100%)	2 (0%)	88	92
1	C	400/410 (98%)	399 (100%)	1 (0%)	92	95
1	D	400/410 (98%)	394 (98%)	6 (2%)	65	69
All	All	1608/1640 (98%)	1596 (99%)	12 (1%)	81	88

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	209	SER
1	A	240	PHE

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Mol	Chain	Res	Type
1	A	452	LEU
1	B	121	TRP
1	B	240	PHE
1	C	240	PHE
1	D	103	LYS
1	D	122	LEU
1	D	240	PHE
1	D	333	ASP
1	D	364	MET
1	D	436	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	25	GLN
1	B	25	GLN
1	C	102	GLN
1	D	102	GLN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 6 ligands modelled in this entry, 6 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

In the following table, the column labelled ‘#RSRZ > 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q < 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å ²)	Q<0.9
1	A	481/490 (98%)	-0.09	13 (2%) 54 53	25, 44, 68, 98	0
1	B	481/490 (98%)	-0.10	12 (2%) 57 56	27, 43, 65, 104	0
1	C	479/490 (97%)	0.05	17 (3%) 44 43	28, 45, 71, 85	0
1	D	479/490 (97%)	0.10	17 (3%) 44 43	31, 47, 73, 85	0
All	All	1920/1960 (97%)	-0.01	59 (3%) 49 48	25, 45, 71, 104	0

All (59) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	208	LEU	5.2
1	A	330	THR	5.2
1	B	121	TRP	4.6
1	D	290	GLY	4.5
1	B	436	VAL	4.5
1	B	331	ASP	4.4
1	D	121	TRP	4.2
1	A	207	SER	4.0
1	A	121	TRP	4.0
1	B	330	THR	3.7
1	C	289	GLY	3.7
1	C	121	TRP	3.5
1	B	11	SER	3.5
1	D	291	GLU	3.4
1	D	122	LEU	3.4
1	A	231	PHE	3.3
1	A	232	PRO	3.3
1	C	119	GLY	3.2
1	B	233	GLY	3.2
1	D	119	GLY	3.2
1	A	210	SER	3.0

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Mol	Chain	Res	Type	RSRZ
1	D	331	ASP	3.0
1	C	355	ALA	2.9
1	D	233	GLY	2.9
1	B	122	LEU	2.8
1	D	231	PHE	2.7
1	B	208	LEU	2.7
1	C	291	GLU	2.7
1	A	120	GLY	2.6
1	B	434	GLY	2.6
1	C	171	GLY	2.6
1	A	11	SER	2.6
1	C	356	ALA	2.6
1	B	120	GLY	2.6
1	B	62	ASP	2.5
1	D	490	THR	2.5
1	A	331	ASP	2.5
1	A	122	LEU	2.5
1	D	12	GLN	2.4
1	D	467	ALA	2.4
1	A	436	VAL	2.4
1	D	171	GLY	2.4
1	C	172	GLY	2.3
1	C	302	VAL	2.3
1	C	230	THR	2.3
1	D	230	THR	2.3
1	C	208	LEU	2.2
1	D	356	ALA	2.2
1	C	331	ASP	2.2
1	A	209	SER	2.2
1	C	62	ASP	2.1
1	D	62	ASP	2.1
1	C	232	PRO	2.1
1	C	120	GLY	2.1
1	D	355	ALA	2.1
1	C	122	LEU	2.1
1	C	118	ALA	2.0
1	B	302	VAL	2.0
1	D	123	LYS	2.0

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates [i](#)

There are no monosaccharides in this entry.

6.4 Ligands [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	FE2	B	501	1/1	0.99	0.11	32,32,32,32	0
3	CL	A	502	1/1	0.99	0.09	45,45,45,45	0
3	CL	B	502	1/1	0.99	0.10	49,49,49,49	0
2	FE2	D	501	1/1	1.00	0.10	36,36,36,36	0
2	FE2	A	501	1/1	1.00	0.09	32,32,32,32	0
2	FE2	C	501	1/1	1.00	0.12	34,34,34,34	0

6.5 Other polymers [i](#)

There are no such residues in this entry.